

**STATEMENT OF BASIS FOR
PROPOSED CORRECTIVE ACTION**

DUWAMISH SEDIMENT OTHER AREA AND SOUTHWEST BANK

BOEING PLANT 2

EPA Identification Number WAD 00925 6819

Administrative Order on Consent 1092-01-022-3008(h)

**U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 10
SEATTLE, WASHINGTON
March, 2011**

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
EXECUTIVE SUMMARY	3
OPPORTUNITY FOR PUBLIC COMMENT	5
FACILITY BACKGROUND	7
PHYSICAL SETTING	8
REGULATORY FRAMEWORK AND CLEANUP LEVELS	11
CORRECTIVE ACTION HISTORY	17
CORRECTIVE ACTION PROCESS	22
PROPOSED ALTERNATIVES	22
EVALUATION OF ALTERNATIVES	28
PROPOSED REMEDY SELECTION	40
REFERENCES	42
FIGURES	47
TABLES	55
APPENDIX	58

STATEMENT OF BASIS FOR PROPOSED CORRECTIVE ACTION

DUWAMISH SEDIMENT OTHER AREA AND SOUTHWEST BANK BOEING PLANT 2, SEATTLE/TUKWILA, WASHINGTON

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Administrative Order on Consent 1092-01-22-3008 (h)

EXECUTIVE SUMMARY

This Statement of Basis contains the U.S. Environmental Protection Agency, Region 10's (EPA's) proposed corrective action (also called corrective measures) for the sediments in and bank adjacent to the Lower Duwamish Waterway (LDW) for the Boeing Plant 2 facility (Plant 2) located at 7755 East Marginal Way South in Seattle and Tukwila, Washington (Figure 1). This Statement of Basis is issued pursuant to Administrative Order on Consent 1092-01-22-3008(h) (Order) under the Resource Conservation and Recovery Act (RCRA), consistent with OSWER Directive 9902.6: "Guidance on RCRA Corrective Action Decision Documents; the Statement of Basis, Final Decision and Response To Comments." It provides background information and explains the proposed final corrective action for the sediments adjacent to Plant 2 necessary to protect human health and the environment. EPA will consider all comments received regarding the proposed corrective action and this Statement of Basis. A written Response to Comments will be prepared before issuing a Final Determination. EPA may select the proposed corrective action, modify the proposed corrective action, select another corrective action, and/or require additional investigation based on new information or public comments.

Plant 2 is located on the east bank of the LDW (Figure 1). Plant 2 occupies approximately 107 acres of developed, topographically flat land covered by buildings and paved yards. Most buildings are slab on grade with below-grade utilities. Plant 2 is bounded on the east by East Marginal Way South, a four-lane arterial, on the south by the Jorgensen Forge facility, an active steel and aluminum forge, on the north by Slip 4 and an Emerald Services, Inc. facility, and on the west by the LDW. The Plant 2 Uplands Area is divided into northern and southern sections by an arterial, 16th Avenue South, which services the former 16th Avenue South Bridge, also called the South Park Bridge, over the LDW. The LDW flows south to north and covers what had been the northern most approximately five miles of the Duwamish River. It was created by the U.S. Army Corps of Engineers in the early Twentieth Century by widening, straightening and

deepening this portion of the river. Its deepest central area over its entire length is a federally maintained shipping or navigation channel. The focus of this Statement of Basis is the sediments adjacent to the facility. These include the sediments from the navigation channel eastward to the top of the bank (Figure 2), referred to as the Duwamish Sediment Other Area (DSOA), the Southwest Bank, Slip 4, and several other much smaller discrete areas defined more fully in the Corrective Action History section.

Boeing and EPA have identified a wide-spread area of contamination in the DSOA, including a variety of contaminants of concern. Polychlorinated biphenyls (PCBs) were detected in most samples, many at high concentrations (a strong indicator of toxicity). Metals were detected at the toe of the Southwest Bank, in an area where metals-containing debris was found in the shoreline fill. Metals, semi-volatile organic compounds (SVOCs), carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and phthalates, were all detected in significant concentrations within the area of PCB contamination. Plant 2 sediments have the largest volumes of high concentrations of PCBs in the LDW (in hundreds of parts per million (ppm or mg/kg)).

Sampling of the DSOA also demonstrated differences in contamination patterns on the north and south sides of the South Park Bridge. Due to these differences, EPA divided the DSOA into two areas: the North Area and the South Area. Two alternatives were evaluated for the North Area (N1 and N2), and four for the South Area (S1-S4). Four of the alternatives (N1, S1, S2, and S3) propose to excavate some of the contamination and cover the remainder with a permanent engineered cap. The engineered cap would be specifically designed to permanently cover the contaminants, and would require monitoring and maintenance in perpetuity. Two of the alternatives (N2 and S4) propose excavation to a target depth of 20 feet of all sediments contaminated above 12 parts per million-organic carbon normalized (ppm-OC) for PCBs, a standard promulgated by the State of Washington to be protective of benthic (bottom-dwelling) invertebrates. Any contamination deeper than 20 feet below mudline would be left in place. Based on the data collected, EPA believes that no contamination left in place will exceed this standard. The excavated sediments would be replaced by refilling the excavation with clean backfill with contamination levels that are protective of the most sensitive receptors to the contamination in the LDW.

EPA proposes to select alternatives N2 and S4, the “full excavation” alternatives, as the cleanup remedy to be implemented for the DSOA. Approximately 200,000 cubic yards of contaminated material over a nearly 15-acre area would be removed and replaced with clean fill at a projected cost of nearly \$38,000,000. The only cleanup remedy evaluated for the smaller areas described above is full excavation. The amount of contaminated material to be addressed in these areas is less than 7% of the total contaminated material. An evaluation of other corrective measures for these areas was not warranted.

Additional information can be found in EPA’s Administrative Record for Plant 2. The RCRA Facility Investigation (RFI) includes detailed information about the nature and extent of contamination in the sediments. The Corrective Measures Study (CMS) (*Duwamish Sediment Other Area and Southwest Bank Corrective Measures Alternative Study, 2010*) includes a detailed evaluation of several cleanup alternatives, including EPA’s proposed alternative. Other documents used by EPA to make this recommendation are listed in the References at the end of this Statement of Basis. EPA encourages the public to review these documents to gain a more comprehensive understanding of the corrective action proposed in this Statement of Basis.

OPPORTUNITY FOR PUBLIC COMMENT

EPA is seeking public comments on this Statement of Basis containing its proposed corrective action for Plant 2 Sediments, and strongly encourages public comment and community participation during the comment period. Comments will be accepted during a 60-day period from March 28, 2011 to May 29, 2011. Comments must be postmarked or e-mailed to EPA by May 29, 2011. Comments should include all reasonably available references, factual grounds, and supporting materials. EPA may allow additional time for public comment on a revised Statement of Basis if EPA determines that any substantial deviation from the proposed corrective action in this Statement of Basis is needed.

EPA will hold a public meeting to receive comments orally and/or in writing on April 27, 2011 at the South Park Community Center, 8319 8th Avenue South, Seattle. For more information about the public meeting, contact Kendra Tyler, 206-553-0041, or Kendra.Tyler@epa.gov. TTY users please call 800-877-8339.

This Statement of Basis and the Corrective Measures Study are available for review at:

U.S. Environmental Protection Agency, Region 10 Library
1200 6th Avenue, 10th Floor
Seattle, Washington
206-553-1289
Hours: Monday-Friday 9am-12pm and 1pm to 4pm

and:

South Park Library
8604 8th Avenue South
Seattle, Washington
206-615-1688
Hours: Monday and Tuesday 1pm-8pm;
Wednesday, Thursday and Saturday 11am-6pm

These documents are also available online at:
<http://yosemite.epa.gov/r10/cleanup.nsf/ldw/>

To submit written comments by mail or e-mail, or for more information, contact:

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Public comments will be summarized, along with EPA's response, in a *Final Decision and Response to Comments for Corrective Action for Boeing Plant 2 Sediments* which will be issued after the public comment period. If no substantive comments are received during the public comment period, EPA intends to select the corrective action proposed in this Statement of Basis.

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FACILITY BACKGROUND

The Boeing Plant 2 facility (Plant 2) is located on the east bank of the Lower Duwamish Waterway (LDW) at 7755 East Marginal Way South in Seattle and Tukwila, Washington (Figure 1). Historically, Plant 2 has specialized in manufacturing aluminum alloy, steel alloy, and titanium alloy parts for airplanes. Plant 2 was built on farmland in the late 1930s and became a significant manufacturing facility during World War II. Major aircraft manufacturing continued until the late 1960's, with significant related manufacturing thereafter until the early 1990's. More recently, Plant 2 has shifted predominantly to research and administration, with only limited manufacturing in the 2-10 Building to support research and development.

Over its operating history hazardous waste and hazardous constituents, which are regulated by the Resource Conservation and Recovery Act (RCRA), have been released at and from Plant 2, including into the LDW. Large electricity generators, transformers and related equipment have operated on Plant 2 for most of its history to support its operations. Poly-chlorinated biphenyls (PCBs) are a hazardous waste constituent commonly found in this type of electrical equipment. PCBs were also a significant component in high performance paints, caulking, and related materials from as early as the 1930s until 1979, when their manufacturing, distribution and use were banned. Significant releases of PCBs at or from Plant 2 as spills and/or other events from electrical equipment were reported at various times by The Boeing Company (Boeing) to EPA as required by law. Concrete joint caulk has been another significant source of PCB contamination at or from Plant 2. PCBs are the most widespread and significant hazardous constituent in the sediments and related areas of Plant 2 addressed by this Statement of Basis. Other hazardous constituents released at or from Plant 2 include various metals and volatile and semi-volatile organic compounds

(VOCs and SVOCs) in solvents, cleaners and associated products, and other petroleum-based hazardous constituents from fuels and other sources.

PHYSICAL SETTING

Plant 2 is located in the central portion of the Duwamish Valley adjacent to the tidally influenced LDW (Figure 1). The Duwamish Valley is bounded to the east by Beacon Hill and to the west by the West Seattle uplands. The Greater Duwamish Valley was formed by the repeated carving action of glaciers that last advanced into this area from British Columbia approximately 15,000 years ago. When the ice sheets began to melt and retreat approximately 13,650 years ago, sea levels began to rise and the saline waters of Puget Sound extended up the Duwamish Valley as far south as Auburn (approximately 16 miles upstream of Plant 2). Approximately 5,700 years ago, the Osceola Mudflow descended from Mount Rainier, depositing a massive layer of sediment into the then marine waters near present-day Auburn and Kent. The glacially carved Duwamish Valley began to be filled by deposition of upstream fluvial sediments of the White, Green, and Black Rivers; these sediments continued to move the mouth of the Duwamish River farther to the north until it reached its current location.

The alluvium included beds of fine silts and sands as fluvial and floodplain deposits, with coarser sands and gravels deposited in areas of higher flow (higher energy). These sediments eventually filled the valley to its current elevation and buried most of the glacially exposed outcroppings of bedrock so that few are now exposed at the ground surface. As the river flooded and migrated back and forth across the floodplain, these sediments were redeposited by the river and continually intermixed with additional riverine and floodplain deposits (Booth and Herman 1998; Windward 2003).

The oldest (deepest) sediments encountered in investigations at Plant 2 consist of marine silt deposited over an underlying glacial till or glaciomarine unit. These two units (the glacial deposits and the marine silt) were encountered both during the RCRA Facility Investigation (RFI) (Weston 1996) and during recent Geotechnical Studies for the new 16th Avenue (South Park) Bridge (PB Americas et al. 2007). The two units form an aquitard that hydraulically isolates the alluvial sediments and aquifer from the deeper strata.

The alluvial sediments above this aquitard are composed of pro-gradational sequence of estuarine and overlying alluvial deposits. The estuarine deposits

are typically fine sands and silts with shells and are found at depth and progress up into a more complex interbedded river (now waterway)-dominated alluvial sequence containing sand, silt, and gravel.

Before industrial development in the Duwamish Corridor, the area in the vicinity of what is now Plant 2 was composed of tidal swamps; the elevation of these tidal swamps is estimated to have been above mean higher high water (MHHW; 11 feet mean lower low water [MLLW] [Blomberg et al. 1988]).

The aquifer system within the Duwamish Valley is typically considered a single continuous aquifer unit found within the more recent alluvium. The groundwater in the Duwamish Valley is typically considered a single continuous aquifer.

Brackish to saline groundwater conditions are encountered in the lower part of the aquifer throughout much of the valley. The density differences of the brackish water and overlying fresh water are expected to have significant impact on groundwater flow (Booth and Herman 1998) with the fresh groundwater (from recent recharge) tending not to mix with the higher density brackish/saline water. The groundwater flow direction within the alluvial aquifer has been mapped at a regional scale and in numerous local areas. As expected in an alluvial river valley, the groundwater flow direction is from the higher elevation valley edges (sources of recharge) toward the river/waterway (discharge point). In general, regional groundwater flow directions are approximately perpendicular to the LDW, with local variations due to changes in alignment (bends in the river/waterway), the presence of slips aligned perpendicular to the waterway, recharge areas, and variations in subsurface materials. Near the LDW, tidal influences cause diurnal changes in the surface water and groundwater levels. Groundwater flow directions temporarily reverse during high tide in areas immediately adjacent to the LDW, creating a saltwater wedge below Plant 2 in the groundwater within 600 feet of the LDW. This phenomenon is temporary and does not prevent the eventual discharge of groundwater to the LDW. The net groundwater flow direction is toward the LDW when the tidal variations are averaged using the method described by Serfes (1991).

The Duwamish River was a meandering generally south to north flowing stream, with frequent seasonal flooding. By 1917, the northern most approximately five miles of the Duwamish River were straightened and deepened to form the Lower Duwamish Waterway (Blomberg et al. 1988). Work on the navigation channel was completed in 1931. The LDW is now approximately 350 to 400 feet wide

with bottom elevations of about -20 feet MLLW. Banks are relatively steep and covered in riprap. The sediments slope at a gentler grade from the toe of the bank/riprap to the navigation channel, generally located 150 to 200 feet from the riprap. A mudflat is visible along much of Plant 2 at low tide, ranging in width from about 130 feet in the north to less than 20 feet near the Southwest Bank at a -2 foot MLLW tide.

An evaluation of selected bathymetric surveys, conducted as part of the LDW remedial investigation for the LDW Superfund Site (Windward 2003) found that intertidal benches along the LDW appeared to be relatively stable over time with little change in elevation but with some net deposition along the navigation channel slopes adjacent to the intertidal benches. The evaluation concluded that changes in elevations outside the authorized navigation channel (between the navigation channel and the intertidal benches) may have been attributable to "...maintenance dredging adjacent to the navigation channel, other dredging activities conducted to improve ship access to berthing areas or marinas, or other erosive events."

Over the years, the navigation channel within the LDW was periodically dredged by the U.S. Army Corps of Engineers (Corps) or other parties to maintain navigation depths. Corps' dredge records show that there are areas along the navigation channel adjacent to the DSOA that have been dredged to at least -32 feet MLLW, 17 feet below the authorized navigation channel depth. These records also show that the Corps, on several occasions, dredged areas adjacent to the navigation channel, extending as much as 75 feet into Plant 2 sediments addressed in this Statement of Basis.

The difference between existing sediment elevations and historical dredging elevations defines the maximum depth of "recently" deposited material from upriver. Sediments that have not been disturbed by dredging, ship traffic, or other erosional events are generally denser than the more recently deposited sediments. This change in sediment density and character has been used to distinguish between recent and older sediments. Sampling of the intertidal benches inshore of the navigation channel generally show less than 3 feet of recently deposited sediments on top of older materials. Samples collected closer to the navigation channel indicate that the area has been dredged or disturbed in the past, with recent deposits ranging from 3 to 9 feet or more below the current mudline. Samples collected immediately adjacent to the navigation channel indicate that the thickness of recent depositional material is as much as 19 feet at

one location off the southern end of Plant 2, and that the transition to denser and sandier, older sediments was often difficult to detect.

REGULATORY FRAMEWORK AND CLEANUP LEVELS

Plant 2 is a RCRA hazardous waste treatment, storage, or disposal (TSD) facility subject to RCRA corrective action order authority in Section 3008(h) of RCRA. As such, it may be required to perform all necessary corrective action or cleanup of hazardous waste or constituents released at or from the facility. A RCRA corrective action Administrative Order on Consent, 1092-01-22-3008(h) (Order) was issued to Boeing in January 1994, requiring the performance of a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) to determine the nature and extent of hazardous constituent releases at or from Plant 2 requiring corrective action (also called corrective measures) and an analysis of alternative corrective measures to address those releases, as well as the implementation of Interim Measures to mitigate or correct ongoing or continuing releases in a manner consistent with future corrective action. The Order allows Boeing to perform final corrective action with EPA oversight pursuant to the Order once it has been selected by EPA in a Final Decision and Response to Comments, or to negotiate an alternative Order or await enforcement action by EPA to compel corrective action implementation. RFI/CMS Orders on Consent do not compel Respondents to agree to implement future Final Decisions (because Respondents would not know what they are agreeing to).

Plant 2 sediments have the largest volumes of high concentrations of PCBs in the LDW (in hundreds of parts per million (ppm or mg/kg)). Beyond the Plant 2 sediments addressed by this Statement of Basis, PCBs and other hazardous constituents released at or from Plant 2 have migrated both northward and southward in the LDW. Final corrective action (or a finding of “corrective action complete”) normally requires a TSD to address all releases from the facility wherever they come to be located in concentrations requiring corrective action to protect human health or the environment. This includes releases from the facility which commingle with releases from other facilities or sources to create concentrations of hazardous constituents above protective levels. While EPA has determined that releases from Plant 2 have migrated to other parts of the LDW which (in commingled combination with releases from other sources) currently exceed cleanup triggering criteria, final corrective action for Plant 2 sediments is proposed in this Statement of Basis without directly addressing these migrated Plant 2 releases as follows.

In the late 1990s, to address wide spread significant levels of contamination in the LDW from many sources, including migrated commingled Plant 2 sources, EPA began to assess the LDW as a prospective Superfund site for the National Priorities List (NPL) under the Comprehensive Environmental Response Compensation, and Liability Act (CERCLA). Unlike RCRA corrective action, CERCLA response or remedial action contemplates an sharing of responsibility among jointly and severally liable parties for commingled releases. NPL listing of the LDW occurred in September 2001, at 66 Fed. Reg. 47583. In December 2000, Boeing and 3 other parties agreed to perform a remedial investigation/feasibility study (RI/FS) pursuant to an Administrative Order on Consent issued jointly by EPA and the Washington State Department of Ecology (Ecology) under CERCLA and Washington's Model Toxics Control Act (MTCA). MTCA was an initiative passed into law by Washington voters in 1988 based on CERCLA. It is very similar to CERCLA although it has generally more stringent cleanup standards. A CERCLA RI/FS and a RCRA RFI/CMS are similarly functionally equivalent. EPA's One Cleanup Program initiative announced in 2003 stresses that while different EPA cleanup laws and programs like RCRA and CERCLA have some different procedures and use some different terms and acronyms, they have the same goals, and should produce the same outcomes.

Among the first decisions made during the CERCLA LDW-wide RI/FS was the identification and selection of worst "hot spot" areas of sediment contamination in the LDW that could be addressed as "early action" without waiting for completion of the full waterway-wide RI/FS. Boeing and the other RI/FS parties (collectively the Lower Duwamish Waterway Group or LDWG) proposed the sediments adjacent to Plant 2 and the neighboring Jorgensen Forge facility as one of these areas. EPA and Ecology then designated Plant 2 sediments as an LDW Early Action Area (EAA) within the LDW Superfund Site process that would continue to be addressed as RCRA Corrective Action. However, because the CERCLA/MTCA process would be addressing the rest of the LDW, and could more equitably address migrated commingled contamination from Plant 2, Plant 2 RCRA corrective action sediment contamination boundaries were established based on the areal extent of residual hazardous constituent contamination in sediments adjacent to Plant 2 that exceed the numerical contaminant concentration criteria of the Sediment Quality Standards (SQS) of the Washington State Sediment Management Standards (SMS). The SMS are outlined along with other regulatory requirements below, along with the reason the SQS were selected in developing the Plant 2 and other EAA boundaries.

Hazardous constituents released at or from Plant 2, especially PCBs, which have migrated to other parts of the LDW are left by this Statement of Basis to be addressed by the LDW CERCLA/MTCA process. The other selected LDW EAAs are: a) the T-117 contaminated sediment area and associated uplands across the LDW from Plant 2; b) contaminated sediments generally in the eastern portion of Slip 4 north of Plant 2 (contaminated sediments generally in the western portion are addressed by this Statement of Basis); and c) two smaller cleanups (Duwamish Diagonal and Norfolk combined sewer overflow area) which were initially planned prior to the LDW RI/FS and were implemented without EPA oversight.

Because the LDW is tidally influenced, with fresh water from the upstream Green River system essentially flowing northward over a tidal salt water wedge from Elliott Bay, releases from Plant 2, as stated above, migrate both northward and southward in the LDW. The largest reported Plant 2 PCB releases or spills occurred at the south end of Plant 2. The much smaller Jorgensen Forge facility located immediately south of Plant 2 is preparing an Engineering Evaluation/Cost Analysis (EE/CA) for non-time-critical removal action for its adjacent sediments and associated shoreline bank soils pursuant to a CERCLA Administrative Order on Consent. The Jorgensen EE/CA should be completed in spring 2011, and EPA anticipates holding a public comment period and issuing an Action Memorandum (the CERCLA equivalent of a RCRA Final Decision) in 2011 to select a remedy compatible with its Final Decision for Plant 2 sediments and bank areas. Because sediments adjacent to both the Plant 2 and Jorgensen Forge facilities contain commingled releases, the LDW CERCLA process has administratively labeled them as a single EAA. Amendments to Boeing's and Jorgensen's respective RCRA and CERCLA Orders with EPA require that the Plant 2 and Jorgensen Forge early action cleanups be coordinated to address sediments in this EAA, particularly in what has been called the "Transition Zone" between the two facilities at the south end of Plant 2 sediments and the north end of Jorgensen Forge sediments. PCB releases from the Jorgensen Forge facility are believed by EPA to be minor compared to those from Plant 2. In addition to comingled PCB releases, metals contamination believed by EPA to have been released primarily from the Jorgensen Forge facility will be addressed in the Transition Zone.

The RCRA corrective action process for Plant 2 required the development of Target Media Cleanup Levels (TMCLs) for all contaminated media and hazardous constituents of concern at the facility. TMCLs are set at levels that

are protective of human health and the environment. They are similar to Preliminary Remediation Goals (PRGs) in the CERCLA remedial process. TMCLs are used to evaluate cleanup alternatives. Final Media Cleanup Levels (FMCLs), like final CERCLA cleanup levels, are selected by EPA with the final remedy after the alternatives analysis. They can be taken from regulatory standards under other laws, or derived from risk-based calculations. Generally, federal or state regulatory standards establish minimally acceptable amounts or concentrations of hazardous constituents (generally hazardous substances under CERCLA and MTCA) that may remain in or be discharged to the environment, or minimum standards of performance for the selected remedy. Risk-based Threshold Concentrations (RBTCs, at times referred to as RBCs without the word "Threshold") based on risks to human health or the environment often dictate setting more stringent standards for cleanup or remedy performance. For hazardous constituents that bioaccumulate and magnify through the food chain, like PCBs, TMCLs are often based on RBCs which are significantly more stringent than regulatory criteria (e.g., regulatory criteria may have been established for a different purpose or at an earlier time).

The only relevant minimum regulatory criteria or standards for Plant 2 and LDW-wide sediments are in MTCA and the SMS (which are part of MTCA). The SMS contain specific numerical standards for the protection of benthic invertebrate organisms which live in marine sediment (and are a critically important part of the food chain). There are however, no SMS or other state numerical standards for the protection of human health, including human consumers of fish and shellfish, or for other biological resources such as birds, fish, or other mammals such as river otter. TMCLs for protection of these receptors are derived from RBCs.

The SMS expressly provide (as do RCRA, CERCLA and MTCA generally) that all sediment cleanups must be protective of human health and the environment. WAC 173-204-570(5). They also provide that SMS criteria for the protection of human health be developed on a site-specific basis (generally through RBCs) WAC 173-204-570(3)(v). For hazardous constituents for which benthic invertebrate organisms are the most sensitive receptor of concern (e.g., copper and zinc), the SMS numerical criteria are the TMCLs, and are applied on a point basis within the biologically active zone of the sediments (identified as the top 60 cm of the Plant 2 sediments). Sediment cleanup standards based on the SMS numerical criteria are established on a site-specific basis within an allowable range of contaminant concentrations. The SQS, also called the sediment cleanup objective, and Cleanup Screening Level (CSL), also called the minimum cleanup

level (MCUL), define this range. WAC 173-340-570(4) specifies that SMS-based sediment cleanup standards shall be as close as practicable to the SQS but shall in no case exceed the minimum CSL. For this reason, for the purpose of developing TMCLs that are protective of benthic invertebrate receptors and to analyze alternatives accordingly, the SQS are used in this Statement of Basis for contaminants for which benthic invertebrates are the most sensitive receptor. As stated above, for contaminants like PCBs, for which human seafood consumers are the most sensitive receptor, TMCLs based on calculated RBCs will be the final media cleanup levels (FMCLs), as further discussed below.

MTCA requires that protection of human health be based on an excess cancer risk of one in a million (1×10^{-6}) for individual carcinogens, and one in one hundred thousand (1×10^{-5}) for all carcinogens collectively at a site, as well as a hazard index of one for other human health risks, and for ecological risks. This is equal to EPA's hazard index standards, but considerably more stringent than EPA's excess cancer risk standards (an acceptable range between 1×10^{-4} and 1×10^{-6}). Washington's excess cancer risk standards are therefore used by EPA for sites or facilities in Washington. TMCLs were calculated at Plant 2 using these criteria where the most sensitive receptors are human consumers of LDW resident fish and shellfish.

There are no state or federal numerical standards for the protection of human health, including people who eat fish and shellfish, or for other biological resources such as birds, fish, or other mammals such as river otter. Instead, cleanup levels for protection of these groups are derived, as set forth above, from RBCs. Human health RBCs are the most stringent and therefore the most important. It is EPA's long-standing policy that cleanup levels must be calculated to protect the most sensitive receptors or populations. Regional tribal members and Asian and Pacific Islander populations are known to consume more fish and shellfish than other populations. The Muckleshoot Tribe has a treaty-granted fishery in the LDW that is currently limited to salmon which live most of their lives in the open ocean. The Suquamish Tribe's treaty-granted usual and accustomed fishing area is just north and west of the LDW and includes fish that use the LDW as part of their home range. There are no reliable studies establishing how much fish and shellfish is consumed from the LDW generally, and no reliable studies of Muckleshoot Tribe consumption rates. Due to longstanding King County Department of Health advisories warning against consumption of resident seafood from the LDW, any study of resident LDW fish and shellfish consumption would not be appropriate because it would likely be biased extremely low.

Consequently, EPA selected a study of the Tulalip Tribe's seafood consumption rate as a surrogate for the Muckleshoot Tribe, because the Tulalip Tribe fishes in a geographically similar area and is believed by EPA to have sufficiently similar overall seafood consumption patterns. A consumption rate of 97.6 grams/day of resident seafood (just over 3.5 ounces) has been used for all LDW sediment cleanup decision making, including the proposed sediment corrective action in this Statement of Basis.

Region 10 has at times in the past made assumptions that led it to believe SMS standards were more stringent than human seafood consumption-based RBCs. Among these were assumptions that if a resident seafood species were unavailable, consumers of resident seafood would not substitute an equal amount of available resident species. Another was "fractioning" contaminant contributions to receptors within a water body among contributing sites or facilities. The SQS concentration for PCBs is 12 ppm total organic carbon normalized (ppm-OC). A protective resident LDW human seafood consumption rate based on this standard (and accepted calculations commonly based on food web modeling to derive the relationship between sediment concentration and tissue concentration of affected seafood) would be less than 1 ounce per day. Such a consumption rate would not be protective of higher seafood consuming populations.

The decision to bound Plant 2 and other LDW EAAs based on sampled SQS exceedences was made before the development of the TMCLs, and before EPA abandoned the assumptions referenced in the preceding paragraph, among others. In 2008, Boeing challenged EPA's use of this consumption rate in the calculation of TMCLs for Plant 2 sediment corrective action using the formal dispute resolution process in the Order. The 18 page "EPA Decision, Target Media Cleanup Level Technical Memorandum" dated September 26, 2008, fully sets forth the bases for these TMCLs. See Table 2 for Plant 2 TMCLs. See Appendix 1 for the September 28, 2008 EPA Decision.

Another important consideration with regard to FMCLs, even if they are based on regulatory requirements (e.g., the SQS) is that they are never set below background concentrations or practical quantitative limits (PQLs). Setting numerical cleanup levels below background is impractical due to recontamination to background concentrations. FMCLs below PQLs, which define what can be measured, are similarly impractical. At completion of the proposed Plant 2

sediment corrective action in this Statement of Basis, the backfill covering the remediated area will meet all TMCLs for all hazardous constituents.

Surface water (i.e., the water column) is also a medium of concern in the LDW, and for Plant 2 corrective action to the following extent. Corrective action addresses releases of hazardous constituents in all media at or from a TSD, and though the water column is part of the LDW Superfund Site, once contamination in Plant 2 sediments and upland soil and groundwater have been controlled and are no longer moving into the LDW, exceedances of water quality standards in the LDW will be a LDW-wide concern no longer affected by Plant 2.

Ultimate PCB and other bioaccumulative contaminant levels in sediments and surface water for the entire LDW will be determined at the end of the LDW CERCLA/MTCA process. EPA in conjunction with Ecology, will consider all ongoing sources in making determinations, including inflowing contaminants from the Green River system, aerial deposition, residual lateral sources, and residual LDW bed loading. Recontamination in this regard will be addressed in the LDW CERCLA/MTCA process.

In summary, TMCLs were adopted from the SQS for contaminants for which benthic invertebrates are the most sensitive receptor. TMCLs derived from risk based calculations using the consumption rate of the Tulalip Tribe from the Toy Study (Toy, et al, 1996), were adopted for contaminants for which human fish and shellfish consumers are the most sensitive receptor. Where a TMCL is more stringent than PQLs, the PQL is the TMCL. EPA proposes to select the TMCLs as the FMCLs upon completion of the public comment and remedy selection process.

CORRECTIVE ACTION HISTORY

RCRA Facility Investigation

During the RCRA Facility Investigation (RFI), samples were collected throughout the intertidal and subtidal areas adjacent to Plant 2. During the Sediment Investigation (Weston 1996) surface sediment samples (0 to 10 centimeters [cm]) were collected at approximately 60 locations within the DSOA. Samples were analyzed for total organic carbon (TOC), total PCBs as Aroclors, metals, and SVOCs. In addition, subsurface sediment cores were collected at 16 locations within the DSOA. Subsurface composite samples (2 to 5 feet long) were

collected from cores and analyzed for TOC, PCBs, metals, and SVOCs. The RFI evaluation indicated the following:

- (1) PCBs were widespread in significantly elevated concentrations (a strong indicator of toxicity). Plant 2 sediments have the largest volumes of high concentrations of PCBs in the LDW (in hundreds of parts per million (ppm or mg/kg)).
- (2) Significantly elevated concentrations of metals were detected in a few locations, predominately at the toe of the Southwest Bank (an area where metals-containing debris was found in the shoreline fill).
- (3) Various metals, SVOCs, primarily carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and phthalates, were all detected in elevated concentrations in the sediments, but always within the broader and more extensive PCB contamination footprint.

Within the DSOA (excluding sediments within 20 feet of the toe of the Southwest Bank, Outfall 12, and the Underbuilding area) metals in surface and core samples were generally not elevated. There were no SQS exceedances for arsenic, chromium, copper, or silver. There was one exceedance of the SQS each for cadmium and lead, three SQS exceedances for zinc, and eight exceedances of the CSL (the less stringent SMS level) for mercury.

In the vicinity of the Southwest Bank, PCBs along with seven metals (cadmium, chromium, copper, lead, mercury, silver, and zinc) were identified as contaminants of concern (COCs). Significantly elevated metal concentrations were largely limited to the toe of the slope at the Southwest Bank, and were limited in depth. Their source is suspected to be bank fill materials. Metals and SVOCs were found in areas that also contained PCB contamination, but the metals and SVOCs contamination was not as extensive or as deep as the PCB contamination.

The investigation was broken into several discrete areas. These areas are identified as the DSOA (sediments from the high water mark to the navigation channel), Southwest Bank, 2-40's Underbuilding Area, Outfall 12, North Bank, Transition Zone, and Slip 4 area. Multiple sampling events within each area are summarized below. The boundary of the Plant 2 sediment corrective action is depicted in Figure 2.

Duwamish Sediment Other Area (DSOA)

The Duwamish Sediment Other Area (DSOA) includes the sediments adjacent to Plant 2 from the navigation channel east to the top of the bank (Figure 2). Significant surface and subsurface data have been collected within and adjacent to the DSOA to define the horizontal and vertical extent of contamination and evaluate possible corrective measures. Twelve sampling events occurred within the DSOA since 2001 and are shown on Table 1. Those samples with SQS exceedances for constituents other than PCBs also had elevated PCB concentrations, confirming that PCBs are the appropriate contaminant for the purposes of defining the sediment corrective action area. Figure 3 shows the extent of PCB contamination within the DSOA in ppm-OC, except when total organic carbon (TOC) concentrations were exceptionally low or high (below 0.5% TOC and above 4.0% TOC, respectively). This is consistent with Ecology guidance which recommends using the SQS dry weight equivalent or CSL dry weight equivalent rather than the TOC-normalized value in these instances. All data collected in the 12 investigations are presented in the *Duwamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010).

Southwest Bank

The Southwest Bank refers to the southernmost portion of Plant 2 fronting the LDW, specifically that section of bank located between the Plant 2 southern border and the 2-49 Building approximately 400 feet to the north (Figure 2). The current bank is steep (approximately 1 to 2H:1V) and consists of riprap and miscellaneous debris fill. Hazardous constituent data collected at the Southwest Bank primarily consist of analyses of surface sediment (collected offshore of the Southwest Bank), surface soil (exposed along the bank itself), subsurface soil (from soil borings within the Southwest Bank), and groundwater. Additional subsurface soil data were collected in 2001 as part of the preliminary design of the then Southwest Bank Interim Measure. Elevated metals concentrations (primarily cadmium, copper, lead, and zinc) in Southwest Bank soils appear to be related to large amounts of debris found within the upper deposits of Southwest Bank fill. PCBs were also detected in the Southwest Bank but do not appear to be correlated or spatially related with elevated metals concentrations. Interim

Measure activities previously slated for the Southwest Bank have been incorporated into the current CMS and this Statement of Basis.

The 2-40's Underbuilding Area

The 2-40s Underbuilding area is an approximately 1,000-foot-long section of buildings that overhang the shoreline bank (Buildings 2-41, 2-44, and 2-49). It is 50 feet wide, supported by wooden piles, and physically separated from the uplands by a continuous bulkhead wall (Figure 2). Running underneath the overhang are various pipes, vaults and other utility infrastructure that supported manufacturing operations within the buildings. The surface beneath the overhang is a steep bank slope covered with riprap extending to a scalloped sediment interface that is only exposed during low tide. The sediments in the Underbuilding area contain elevated concentrations of metals, SVOCs, and PCBs. The elevated concentrations of these hazardous constituents are, with few exceptions, limited to 6 feet below the existing sediment surface.

There have been two interim measures (IMs) in this area; the Underflow Flume IM and Building 2-41 Debris Area IM. Sediment samples prior to the Underflow Flume IM (Weston 1998) indicated elevated concentrations of PCBs. Approximately 30 cubic yards of sediment were removed at the Underflow Flume with clean backfill placed in the excavation. Some sediments with concentrations of PCBs above the SQS were left below the backfilled excavation with the understanding that their removal would occur during the final sediment corrective action.

The Building 2-41 Debris Area IM (Pentec 2000)) targeted an isolated area of elevated lead concentrations. Approximately 20 cubic yards of sediment were removed and replaced with clean fill.

Outfall 12 Area

Outfall 12 is in the intertidal zone on the bank at the south end of Building 2-49, adjacent to the Southwest Bank (Figure 2). An IM removed approximately 20 cubic yards of sediment and soils with elevated concentrations of PCBs (Weston 1998). Sediments with concentrations of PCBs above the SQS remain below the backfilled interim measure excavation.

Additional sampling in the Outfall 12 area was conducted during the DSOA and Outfall 12 characterization (Pentec and FSM 2001), which revealed that elevated PCB concentrations extend to a depth of approximately 5 to 6 feet below mudline (approximately 2 feet below the IM backfill) in an approximate 10 by 12 foot area. Outside the IM footprint, elevated PCB concentrations are limited to 2 to 3 feet below mudline.

North Bank

For the purposes of this Statement of Basis, the North Bank area is defined as the LDW bank from the high water mark to the top of slope from the South Park Bridge north to Slip 4 (Figure 2). The 2-10 Building in this area includes a pile-supported overhang that extends approximately 75 to 100 feet over a rip-rapped bank that slopes down to the DSOA sediments. Two Enhanced Reductive Dechlorination IMs are being conducted within the 2-10 Building near the underlying bulkhead. These areas within the 2-10 Building are excluded from the definition of the North Bank area, and will be addressed in the future with the remaining Plant 2 Uplands.

Transition Zone

This area includes portions of the sediments and associated banks adjacent to both the Plant 2 and Jorgensen Forge facilities. The southern boundary of the DSOA extends approximately 150 feet south of the Plant 2/Jorgensen Forge property line (Figure 2). The Transition Zone extends from the southern Boeing property line to this southern boundary. Coordination between the two cleanups, including the Transition Zone between them, was addressed by a 2008 Memorandum of Understanding (MOU) between Boeing and Jorgensen Forge facility responsible parties. The MOU was approved by EPA and incorporated into Boeing's and Jorgensen's respective EPA Orders.

The shoreline boundary generally extends to the top of the bank along the Plant 2 facility and to the toe of the rip-rapped slope along the northern portion of Jorgensen Forge facility. The area inland of the top of the bank along the Plant 2 facility will be addressed in the Plant 2 Uplands cleanup. The area within the Transition zone was fully investigated and the data was incorporated in the *Duamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010).

Slip 4

Areas within the Boeing-owned portion of Slip 4 outside of the LDW Slip EAA are addressed in this Statement of Basis. A thorough review of available data from this area, including PCB SQS exceedances, is in the *Duwamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010). Further evaluation of this area may be conducted during the design and/or engineering phases of corrective action implementation, as deemed necessary by EPA.

CORRECTIVE ACTION PROCESS

The corrective action process, a necessary component of TSD regulation under RCRA, is set forth in the Order, consistent with EPA policy and guidance. Section VIII of the Order requires that Boeing perform an RFI to determine the nature and extent of hazardous constituent releases requiring corrective action at Plant 2, and a CMS to evaluate and compare corrective measures alternatives. After seeking public comment on proposed corrective action in a Statement of Basis, EPA will publish a Final Decision and Response to Comments, which will address public comments and explain the bases and rationale for EPA's decisions.

Because the contamination patterns were different to the north and south of the South Park Bridge, EPA divided the DSOA into two areas. The precise boundary between these areas is Section 26+00, a survey mark approximately 150 feet south of the South Park Bridge. Six alternatives were evaluated in the CMS for the DSOA sediments; two for the North Area and four for the South Area. For the smaller areas described above, only one potential remedy was proposed: excavation of sediments with contaminant concentrations above the SQS numerical criteria and replacement with clean fill that meets the appropriate TMCLs. The material to be addressed in these smaller discrete areas is less than 7% of the total volume to be addressed. The criteria for analyzing and comparing corrective measure alternatives are found in Task 2 of Attachment A of the Order, and are discussed below.

PROPOSED ALTERNATIVES

NO ACTION. “No Action” means that no remediation would be conducted. This alternative is not protective of human health or the environment. Consistent with EPA guidance and policy, the No Action alternative is retained for comparison purposes only.

DSOA North Area

The two DSOA North Area corrective action alternatives are represented in Figure 4 and described below. The removal area for each of the North Area alternatives is 9.56 acres.

North Area Alternative 1 (N1)

Under Alternative N1, the DSOA North Area would be dredged to a uniform depth of 4 feet. After the 4-foot dredge, areas where hazardous constituent concentrations meet the SQS would be backfilled with clean sand, and areas where these concentrations exceed the SQS would be capped. Based on preliminary performance modeling, the cap in the inshore area would consist of a 2-foot attenuation layer, a 1-foot armor layer, and a 1-foot habitat layer. The cap in or within 10 feet of the navigation channel would be similarly constructed, although the top layer would not exceed -19 feet MLLW.

The maximum known concentration of PCBs that would be left in place under a cap is 293 ppm- OC (24 times the SQS) or 6,000 ppb dry-weight (46 times the SQS dry weight equivalent). Because carbon levels in sediment vary significantly and affect the availability of hazardous constituents like PCBs to potential receptors, there is significant variation in carbon normalized and dry weight comparisons to SQS levels.

The estimated dredge volume for this alternative is approximately 142,000 cubic yards. This includes a substantial volume of sediment that does not exceed the SQS due to the dredge cut and side slopes that are required to install a cap adjacent to the navigation channel. Dredged sediment (often called spoil) would be disposed of at an appropriate permitted upland disposal facility.

North Area Alternative 2 (N2)

This alternative is a variable-depth dredge and backfill design based on the interpretation of the geospatial analysis (Figure 4). Over most of the area, elevated concentrations of PCBs are confined to the top 2 to 5 feet. In a few areas adjacent to the channel, elevated concentrations of PCBs extend up to 15 feet below the existing surface. The minimum proposed dredge cut over the entire North Area would be 2 feet with deeper dredge cuts in areas where concentrations of PCBs are above the SQS at depth. All North Area sediments with hazardous constituent concentrations above the SQS would be removed. After dredging, the area would be backfilled with clean sand to return the surface to the existing grade. Backfill within ten feet of the navigation channel and within the channel itself would not exceed -19 feet MLLW in order to maintain the authorized channel depth.

The total estimated dredge volume for Alternative N2 is 114,000 cubic yards. The sediment that would be removed would be disposed of at an appropriate permitted upland disposal facility. No capping would be required under this alternative.

DSOA South Area, including the Transition Zone

The corrective action alternatives in the South Area, including the Transition Zone, are presented on Figure 5 and described below. Four alternatives were evaluated. The South Area is approximately 4.25 acres.

South Area Alternative 1 (S1)

This alternative is essentially the same as North Area Alternative N1. It would require a uniform 4-foot total dredge depth and cap or backfill in the inshore areas, with capping in or near the navigation channel as shown in Figure 5. After the 4-foot dredge, areas where hazardous constituent concentrations remaining in sediments meet the SQS would be backfilled with clean sand, while areas with concentrations exceeding the SQS would be capped. Based on preliminary performance modeling, the cap in the inshore area would consist of a 2-foot attenuation layer, a 1-foot armor layer, and a 1-foot habitat layer.. The cap in or within 10 feet of the navigation channel would be similarly constructed, although the top layer would not exceed -19 feet MLLW.

The maximum known concentration of PCBs that would be left in place under a cap is 801 ppm- OC (67 times the SQS) or 14,000 ppb dry-weight (108 times the

SQS dry weight equivalent). The estimated dredge volume for this alternative is approximately 43,000 cubic yards. Dredged sediment would be disposed of at an appropriate permitted upland disposal facility.

South Area Alternative 2 (S2)

This alternative combines a variable-depth dredge with a backfill design in approximately 45 percent of the South Area. In the remaining 55 percent, a uniform 6-foot total dredge depth would be followed by capping or backfilling. A cap would be installed as shown in Figure 5 along the navigation channel. Areas where hazardous constituent concentrations in the remaining sediments meet the SQS would be backfilled with clean sand meeting TMCL standards. Areas where these concentrations exceed the SQS would be capped. The cap would consist of a 2-foot attenuation layer, a 1-foot armor layer, and at least a 1-foot habitat layer to restore the grade. The cap in or within 10 feet of the navigation channel would be similarly constructed, although the top layer would not exceed -19 feet MLLW in order to maintain the authorized channel depth.

The maximum known concentration of PCBs that would be left in place under a cap is 244 ppm- OC (20 times the SQS) or 6,200 ppb dry-weight (6 times the SQS dry weight equivalent). The estimated dredge volume for this alternative is approximately 60,000 cubic yards. Dredged sediment would be disposed of at an appropriate permitted upland disposal facility.

South Area Alternative 3 (S3)

This alternative combines a variable-depth dredge with a backfill design in approximately 70 percent of the South Area. In the remaining 30 percent, a uniform 11-foot total dredge depth would be followed by capping or backfilling. Areas where hazardous constituent concentrations remaining in sediments meet the SQS would be backfilled with clean sand, while areas where these concentrations exceed the SQS would be capped. The cap would consist of a 2-foot attenuation layer, a 1-foot armor layer, and at least a 1-foot habitat layer to restore the grade. The cap in or within 10 feet of the navigation channel would be similarly constructed, although the top layer would not exceed -19 feet MLLW.

The maximum known concentration of PCBs that would be left in place under a cap is 107 ppm- OC (9 times the SQS) or 3,490 ppb dry-weight (3.5 times the SQS dry weight equivalent). The estimated dredge volume for this alternative is

approximately 81,000 cubic yards. Dredged sediment would be disposed of at an appropriate permitted upland disposal facility.

South Area Alternative 4 (S4)

This alternative combines a variable-depth dredge up to 20 feet with a backfill of clean sand that meets TMCLs. In approximately 50 percent of the South Area, concentrations of PCBs are confined to the top 2 to 6 feet. The minimum proposed dredge cut over the entire South Area would be 2 feet with deeper dredge cuts in areas where there are concentrations of PCBs above the SQS at depth. Based on available data, all South Area sediments with hazardous constituent concentrations above the SQS would be removed except in four locations.

Figure 6 illustrates the post-dredging maximum total PCB concentrations in the South Area. As noted in the figure, at each of these four locations the proposed dredge cuts are four feet deeper than the deepest sample analyzed. Based on the observed contaminant concentrations in other borings, removing four feet of additional material should remove all material above SQS. If the proposed dredging does not remove all contaminants above the SQS, EPA has determined that the presence of minimal concentrations of contaminants at least 20 feet below the surface does not present any significant risk to human health or the environment and a sediment cap would not be required.

After dredging, the areas would be backfilled with clean sand to return them to the existing grade. Backfill within ten feet of the navigation channel and within the channel itself would not exceed -19 feet MLLW in order to maintain the authorized channel depth.

The estimated total dredge volume for South Area Alternative S4 is 86,000 cubic yards. Dredged sediment would be disposed of at an appropriate permitted upland disposal facility. No capping would be required.

Other Areas

Only one potential remedy, excavation of all contaminated material, is proposed for these areas. The amount of material proposed for removal in these areas is

less than 7% of the total volume of contaminated sediments addressed by this Statement of Basis.

Southwest Bank (including Outfall 12)

The Southwest Bank contains approximately 5,500 cubic yards of material containing elevated concentrations of PCBs and other hazardous constituents. Nearly all of the Southwest Bank would be removed during DSOA dredging, and the excavated surface would be backfilled with clean material. The removed material would be disposed of in an appropriate permitted upland disposal facility. Removing the Southwest Bank removes the risks of recontamination of DSOA sediments from the Bank during dredging, and over the long term. The removal of material adjacent to a sheet-pile containment wall located in this area will be designed to ensure it is not damaged during construction.

Contaminated sediments with hazardous constituent concentrations above the SQS within the footprint of the Outfall 12 Interim Measure described earlier in this Statement of Basis will be removed to a depth of approximately 6 feet below mudline. The excavated area would be backfilled with clean sand. Samples will be taken from above the high water mark after excavation to ensure contaminants have been removed. These samples will also ensure proper disposal of excavated material that may require special handling due to high concentrations of PCBs.

2-40s Underbuilding Area

The 2-40s Buildings (Buildings 2-41, 2-44, and 2-49) and associated structures listed below are slated for demolition as part of the redevelopment of Plant 2. These buildings overhang an area of sediment, riprap, equipment vaults and bulkheads. Sediments with hazardous constituent concentrations above the SQS (approximately 10,000 cubic yards) would be removed as part of dredging operations in the DSOA, and the excavated area would be backfilled with clean sand. Like the Southwest Bank, the design of the 2-40s Underbuilding Area corrective measure would be integrated into the larger corrective action. Samples will be taken from above the high water mark to ensure contaminants have been removed.

Slip 4

Areas within the Boeing-owned portion of Slip 4 outside of the LDW Slip 4 EAA are addressed in this Statement of Basis as part of the north area alternatives. A thorough review of available data from this area, including PCB SQS exceedances, is in the *Duwamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010). Further evaluation of this area may be conducted during the design and/or engineering phases of corrective action implementation, as deemed necessary by EPA. This area will be addressed and included in North Area Alternative 2 corrective action.

North Bank

The North Bank will be addressed by the Uplands corrective measures process.

Post Construction Monitoring

All of the corrective action alternatives include post construction monitoring. Groundwater and stormwater will be sampled semi-annually to ensure Plant 2 is not the source of any sediment recontamination. The clean sediment surface will also be monitored for at least 10 years. If contamination is revealed in the groundwater or stormwater, Plant 2 releases would have to be controlled and recontamination from Plant 2 sources would have to be addressed. This work would be performed under CERCLA or MTCA as part of the LDW-wide process. If Plant 2 sediments become recontaminated and Boeing can demonstrate that the contaminants did not originate from Plant 2, this recontamination would be addressed by the responsible parties for these releases.

EVALUATION OF ALTERNATIVES

The Order lists the specific criteria for evaluating corrective measures alternatives. These include four General Standards:

- (1) Protection of human health and the environment,
- (2) Attainment of cleanup levels,
- (3) Control source of releases, and
- (4) Compliance with applicable standards.

The criteria also include five Decision Factors:

- (1) Long-term reliability and effectiveness;
- (2) Reduction of toxicity, mobility, or volumes of wastes;
- (3) Short-term effectiveness;
- (4) Implementability; and
- (5) Cost.

More recent EPA policy and guidance expressly emphasizes consideration of anticipated future and current land and/or resource uses, preferences for permanent solutions and the use of treatment to address principal threat wastes to the extent practicable, as well as community acceptance of selected corrective action in Final Decisions which was always implied by the public comment requirement. As mentioned earlier, consistent with EPA's One Cleanup Program initiative, RCRA corrective action and CERCLA remedial action decision making criteria are generally functionally equivalent. They both emphasize protection of human health and the environment as the first overarching criterion to be attained and maintained through source control by meeting cleanup levels measured over the long and short term, factoring in implementability, cost, and public opinion and acceptance.

Protection of Human Health and the Environment

This General Standard is the single most important evaluation criterion. It provides the critical threshold all alternatives must meet to warrant further consideration. All of the alternatives except No Action meet this threshold criterion, but with varying degrees of permanence, reliability or certainty, reduction of hazardous constituents left in the environment, and cost. Each of these alternatives results in at least two feet of clean fill material that meet TMCLs over the entire DSOA and Other Areas addressed in this Statement of Basis. This clean material extends through the full biologically active zone and cuts off the pathway to any human or ecological receptors for residual hazardous constituents below. An engineered sediment cap for alternatives where underlying material exceeds the SQS would isolate the contaminated materials while leaving them in place. However, removing all concentrations of hazardous constituents above the SQS provides a level of permanence and reliability that no engineered cap can provide, particularly over longer periods of time.

The Seattle area is known to be subject to earthquakes and other natural disasters. While sediment caps can be designed to withstand major earthquakes

or other natural disasters of similar scale, sediments may liquefy when shaken (known as liquefaction). An engineered cap could be displaced or damaged such that it no longer covered contaminated sediments. If underlying concentrations of hazardous constituents are not significantly elevated, then the potential mixing of underlying sediments with cap materials during liquefaction should not create significant risks. However, where underlying residual concentrations are significant, residual risks in the event of liquefaction followed by cap displacement are important to consider.

Because a combination of Alternatives N2 and S4 would remove all hazardous constituent concentration above the SQS, these alternatives result in the smallest possibility of hazardous constituent exposures following a severe earthquake or other disaster of a similar scale.

Overall, alternatives that leave lower residual levels of hazardous constituents in the sediments beneath clean material are more protective than alternatives that leave higher levels. Therefore, Alternative S3 is more protective than S2, which is more protective than S1. Alternative S1 would leave a projected maximum PCB concentration that is 67 times the SQS (or 108 times its dry weight equivalent). Alternative S2 would leave a projected maximum PCB concentration that is 20 times the SQS (or 6 times its dry weight equivalent). Alternative S3 would leave a projected maximum PCB concentration that is 9 times the SQS (or 3.5 times its dry weight equivalent). Alternative N1 would leave a projected maximum PCB concentration that is 24 times the SQS (or 46 times its dry weight equivalent). Alternatives N2 and S4 would remove all contaminants above the SQS. As these alternatives do not require long term maintenance and/or repair or replacement of an engineered cap, they are the most protective of human health and the environment.

Attainment of Cleanup Levels and Compliance with Applicable Standards

These two General Standards as explained in the Regulatory Framework section above are related and may be considered together while comparing corrective action alternatives. Following implementation of any of the alternatives except No Action, sediments found at the surface and within the biologically active zone will meet the TMCLs. These cleanup levels are based on risk calculations designed to protect people who eat resident fish and shellfish from the LDW, as well as ecological receptors such as benthic invertebrates, juvenile salmonids, other fish, river otter and other mammals, and shorebirds. The only applicable

sediment standards are the SMS. Any of the proposed alternatives except No Action will meet this standard.

Alternatives that leave residual levels of hazardous constituents that exceed the TMCLs or that exceed the SQS, and therefore present a risks to potential human and ecological receptors if they became exposed, rank lower in preference than alternatives that remove more contaminated materials, regardless of any future contingencies. Furthermore, alternatives that would require more future maintenance or ultimate replacement also rank lower. Therefore, a combination of Alternatives N2 and S4, which would remove all hazardous constituent concentration above the SQS, and would require the least repair or maintenance, rank highest for both of these General Standards, followed by a combination of N1 and (in descending order of rank) S3, S2 and S1.

Control Source of Releases

While the control of sources of contamination or recontamination, such as contaminated stormwater or groundwater from Plant 2 Uplands, do not provide a basis for selection among the sediment corrective action alternatives in this Statement of Basis, source control is a necessary component of any successful sediment corrective action. These potential sources, as well as potential recontamination of clean cap or fill materials from underlying sediment contamination, are discussed below.

Potential Recontamination from Stormwater

The entire Plant 2 stormwater system, including all lines, drains and outfalls, has been thoroughly evaluated and largely rebuilt. The most contaminated lines and outfalls were properly abandoned, replaced or rerouted as Interim Measures under EPA's oversight. This work includes the X and Y lines and outfalls (see Figure 7), which contained elevated levels of PCBs, and have been cleaned and closed. Stormwater in this area is now directed through storm line Z and passes through a vortex separator to remove suspended solids, including PCBs. A rigorous ongoing hazardous constituent monitoring regime has been imposed on the renovated system as the replacement and/or upgrading of existing stormwater lines continues. Work on these upgrades (addressed in separate Plant 2 upland study documents) will be completed before the sediment corrective action begins.

The current source-control sampling program requires sampling of suspended solids and water at six locations on five storm lines, in addition to water only samples on two additional storm lines. Beginning in the 2010-2011 rainy season, Boeing was required to collect whole-water samples for PCB analysis. The suspended solids data will be used to find sources of contamination, as well as gauging the potential for PCBs and metals to recontaminate LDW sediments.

In addition to this work, Boeing is continuing to trace PCB sources from building slabs, and in sediments accumulated over time in the stormwater piping system. The final action to remove PCB caulking present in the concrete joint was completed in the summer of 2010. Property-line outfalls located on the Jorgensen Forge property (Figure 7) just beyond the Plant 2 southern boundary, which contained significant PCB contamination from Plant 2, have also been addressed. Other actions have included cleaning catch basins and storm lines with high-pressure jetting. Fabric inserts have been placed in catch basins and manholes, and accumulated solids are periodically sampled to further distinguish sources at the surface from those that may still be present in the stormwater drainage system. Finally, building components are being evaluated as possible sources of PCBs and metals. Annual testing of suspended solids in the drain system will confirm the effectiveness of these measures or will prompt further removal actions.

Potential Recontamination from Groundwater

The potential for the DSOA sediments to be recontaminated by groundwater carrying contaminants into the backfill/cap material was carefully evaluated. This evaluation was conducted using a tiered analysis which looked at different assumptions. See the *Duwamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010) for further information regarding these analyses.

Initial results indicated that PCBs (Aroclor 1260)) and some metals, including mercury and zinc, could recontaminate the sediments to levels slightly exceeding the SQS. Further evaluation considered the number of wells where PCBs have been detected (one), how PCBs are transported within groundwater, and high turbidity levels in the samples (for both metals and PCBs). The later analysis indicated that only the zinc present in one groundwater monitoring well may cause some recontamination of the sediments. The alternatives for cleaning up this zinc contamination will be evaluated in conjunction with the Plant 2 Uplands

corrective action evaluation of whether additional excavation of the Southwest Bank in the vicinity of the affected well may be required to ensure protectiveness.

Ongoing shoreline groundwater monitoring will continue throughout implementation of all corrective action at Plant 2 and into the future.

Potential Recontamination of Cap or Fill Material from Underlying Sediment Contamination

Alternatives N1, and S1, S2 and S3 would leave PCB concentrations exceeding the SQS at depth in some areas. The potential for this contamination to impact the habitat zone of the engineered cap would have to be fully evaluated during the design process if any of these alternatives were selected. Alternatives N2 and S4 propose removal of all sediments contaminated above SQS and do not include capping. These alternatives rank highest for this General Standard because there is no possibility of recontamination from residuals to levels exceeding the SQS. A combination of N1 and in descending order, S3, S2 and S1 would rank lower for this criterion based on the level of recontamination that could occur.

Potential failure of a cap/backfill may be caused by a number of forces, including scour forces from vessel propeller wash, vessel wakes, river or waterway currents, and most catastrophically from earthquakes or other disasters of similar scale. Structural failure of an installed cap/backfill itself or the structural failure of the underlying sediments during or after the placement of cap/backfill material is also of concern. Structural failure potential focuses on the bearing capacity of the underlying sediments, slope stability under the different cap/backfill alternatives, and the potential for liquefaction of the cap/backfill during a seismic event. Analyses of vessel and wake scour, LDW scour, and structural cap failure are included in the *Duwamish Sediment Other Area and Southwest Bank Corrective Measure Alternatives Study* (AMEC, 2010). An earthquake with a 0.3g or larger acceleration could cause significant damage or displacement through liquefaction below a proposed cap, and for this reason caps are considered less protective than alternatives that do not require them. Fill material in an engineered waterway like the LDW, which has a substantially greater potential to liquefy than natural sediments or adjacent uplands, increases this possibility.

Long-Term Reliability and Effectiveness

This first Decision Factor, along with the second (reduction of toxicity, mobility, or volume of waste) strongly weighs in favor of the selection of Alternatives N2 and S4 to remove all sediments contaminated above the SQS. The combination of Alternatives N2 and S4 rank together as the most effective and reliable alternative presented. Potential damage or exposure to significant contamination cannot occur, regardless of the magnitude of any contingency, catastrophe, duration of time, or more ordinarily, from normal activities in a metropolitan urban waterway.

Additionally, by avoiding engineered capping, implementation of Alternatives N2 and S4 would allow maintenance dredging to proceed more efficiently and effectively without the possibility that dredging operations could undermine or otherwise damage an engineered cap. As other improvements or activities within this reach of the LDW prove necessary or desirable, the absence of carefully maintained caps will be advantageous. Potential future activities such as installation of fiberoptic cables or other infrastructure would be simplified if engineered capping in the LDW is avoided. Currently, King County is planning a new South Park Bridge across the LDW. The in-water structure for the new bridge would be constructed in and through the sediment cap proposed in Alternative N2, increasing the complexity and cost of the bridge replacement.

As noted above in the subsection discussing recontamination from underlying sediments, Alternatives N1 and in descending order, S3, S2 and S1 would rank lower for this Decision Factor based on the degree or level of recontamination that could come into contact with human and/or ecological receptors.

Reduction of Toxicity, Mobility, or Volumes of Wastes

Alternatives N2 and S4 reduce toxicity to a greater extent than any of the other proposed alternatives because they leave behind the least toxic levels of contaminants. They also reduce (or literally eliminate) the mobility of the greatest amount of contaminants, i.e., all of those above the SQS, because they would no longer be present in the LDW with the potential to migrate anywhere. They would be safely confined in an appropriately permitted disposal facility.

Alternatives N2 and S4 will not result in the greatest reduction in the volume of waste. While this is often used as a gauge of environmental benefit, comparison between Alternatives N1 and N2 reveals how it can be misleading. As discussed

above, Alternative N2 is more protective than Alternative N1 because it proposes to remove all hazardous constituents above the SQS in Plant 2 sediments. However, N2 would remove only 114,000 cubic yards (cy) of sediment while N1 would remove 142,000 cy. This is because N2 removes a substantial volume of material that likely does not exceed the SQS due to the dredge cut and side slopes that are required to install a cap adjacent to the channel. South Area Alternatives S1 through S4 remove approximately 43,000, 60,000, 81,000 and 86,000 cy of material, respectively, which is generally consistent with the expectation that the removal of more volume is generally beneficial. The discrepancy between N1 and N2 illustrates that the hazardous constituent concentrations, along with volumes of hazardous constituents that remain, is generally a much better overall indicator of comparative merit, which is why this Decision Factor considers toxicity, mobility and volume together. S1, S2, and S3, like N1, also remove a substantial volume of relatively clean material due to the dredge cut and side slopes that are required to install a deep cap adjacent to the channel. For this reason the similarity in volumes among the South Area alternatives should not be viewed as indicative of their relative merit.

For this Decision Factor, considered as a whole, a combination of N1 and in descending order, S3, S2 and S1 would rank lower than Alternatives N2 and S4, based on the degree or toxicity of recontamination that could affect human and/or ecological receptors.

Short-Term Effectiveness

This Decision Factor compares the effectiveness of projected outcomes shortly after construction of the various alternatives, as well as effects during implementation. These include risks to workers and the community during construction that cannot be readily controlled, unavoidable environmental impacts, and the duration of construction of each alternative.

Absent the occurrence of a major earthquake or other disaster shortly after implementation, there should be no difference in the effectiveness of the alternatives other than No Action. Similarly, since any combination of North and South Area alternatives is projected to require one to two construction seasons to complete, they are also equal in this respect. There are no discernable differences in the risks to implementing workers or the community. Potential short-term impacts to Tribal and other fishers exist for all of the alternatives depending on the timing of the implementation of the remedy. Risks to fishers

will be minimized by coordinating implementation with the Tribes and others to minimize disruption and inconvenience to the maximum extent practicable. During implementation of any of the alternatives, risks to workers (including potential volatilization of PCBs during sediment dredging and handling) will be minimized by implementation of a Health and Safety Plan to ensure appropriate hazards are identified and safety precautions are taken. These factors are consistent among the active alternatives.

During dredging, the short-term suspension of sediments, including hazardous constituents, is generally unavoidable, although the degree of suspension varies based on dredging methods, techniques and precautions. These risks will be minimized to the maximum extent practicable through the use of equipment and technologies that will be thoroughly evaluated during design. Among the alternatives, it can be anticipated that those with greater dredging volume may run a higher risk of contaminant re-suspension. Based on the proposed dredge volumes discussed above, major differences among the alternatives are not anticipated. For this Decision Factor, there are no distinctions among the alternatives to significantly favor or disfavor any particular alternative.

Implementability

“Implementability” compares the technical and/or administrative ease with which alternatives may be constructed. More specific factors include the projected difficulties in securing or obtaining necessary equipment, government-issued permits or approvals, or the satisfactory completion of specific governmental reviews and/or consultation processes. No discernable differences among the alternatives are anticipated regarding permitting issues. There are no significant distinctions among the alternatives to favor or disfavor any of them, though the selection of a more protective alternative may be looked upon more favorably by other governmental authorities in permitting, approval and/or consulting roles. Governmental permits, approvals and processes include:

- (1) U.S. Army Corps of Engineers Section 10/404 Permit
- (2) Endangered Species Act Section 7 Consultation with the National Marine Fisheries Service and U.S. Fish and Wildlife Service (the Services) regarding their listings of certain salmon and bull trout species and their habitats

- (3) Shoreline Substantial Development Permits
- (4) Washington Department of Fish and Wildlife Hydraulic Project Approval
- (5) Washington State Department of Ecology Section 401 Water Quality Certification/ Modification
- (6) Ecology Coastal Zone Management Act Consistency Determination Grading and hauling permits
- (7) Washington State Office of Archaeology and Historic Preservation consultation on potential effects to significant cultural resources

Readily available excavating or dredging equipment capable of meeting all dredging performance requirements and goals should pose no difficulties. Plant 2 sediments are generally comparatively shallow and easy to access. Near-shore area dredging may need to be phased with the tides to ensure access to shallower areas. Cap and/or backfill material would generally consist of clean dredged or imported sand and rock. Imported material in any volume or grain-size distribution required by the design would be readily available by barge. Depending on timing, cap/backfill material may be available from a maintenance dredging activity in the Puget Sound area if the material meets the TMCL-compliant quality standards. Cap/backfill material can be placed directly from barges by clamshell dredge. The clamshell can also be used to dress (smooth) the top surface of the cap/backfill after placement. In near-shore areas the cap/backfill may be placed by excavator or conveyor systems.

The construction work window, without a modification, would be maximally from October 1 to February 15 (approximately 4.5 months). Specific timing will be stipulated as a Section 10/404 permit condition and additional time may be requested from the Corps in consultation with the Services. Timing could also be affected by necessary coordination between Jorgensen Forge and Plant 2 implementation schedules.

Cost

The various combinations of North and South Area alternatives all share a common cost associated with implementing the proposed corrective measure

alternatives for 2-40s Under-building area, Outfall 12, the Southwest Bank, and Slip 4. These proposed corrective measures total \$2,719,000. In addition there are other costs (\$4,093,000) that are common to all the North and South Area alternatives, including design permitting, mobilization/demobilization, construction documentation, water quality monitoring, surveying, and construction monitoring. Long-term operation, maintenance, and monitoring for capping alternatives are included in the cost estimates.

If determined to be necessary by EPA, additional costs may be incurred by the construction of coffer dams or installation of silt curtains in sections of the LDW to prevent contaminated sediments from recontaminating other areas. Since the remedy has not been selected, these costs are not included at this time.

The following estimated costs include dredging, capping/backfilling, and disposal of dredge spoils but not the common costs in the preceding paragraph.

North Area Alternatives Estimated Costs

Alternative	Estimated Dredge Volume (cy)	Estimated Cost
N1N1 – 4-foot Dredge & Cap/Backfill	142,000	\$23,046,000
N2N2 – Variable-Depth Dredge and Backfill	114,000	\$18,191,000

South Area Alternatives Estimated Costs

Alternative	Estimated Dredge Volume (cy)	Estimated Cost
S1S1 – 4-foot Dredge & Cap/Backfill	43,000	\$7,110,000
S2S2 – Variable dredge depth/backfill inshore and 7-foot nominal cut with capping offshore	60,000	\$10,250,000
S3S3 – Variable dredge depth/backfill inshore and 13-foot nominal cut with capping offshore	81,000	\$13,393,000
S4S4 – Variable dredge depth and backfill	86,000	\$15,583,000

The highest ranking combination of alternatives for this Decision Factor is N2 and S1, followed by S2, S3 and S4 in that order. This Decision Factor solely considers cost.

Community Acceptance

EPA will evaluate community acceptance following public comment as outlined in the Opportunity for Public Comment subsection of the Executive Summary.

PROPOSED CORRECTIVE ACTION SELECTION FOR PLANT 2 SEDIMENTS

North Area Alternative

All corrective action must meet each of the four General Standards as set forth in the Order: the threshold standard of protection of human health and the environment; attainment of cleanup levels and compliance with applicable standards; and control of sources of releases. These Standards are achieved with a greater degree of permanence, reliability and certainty by Alternative N2. Alternative N2 also ranks highest for three of the five Decision Factors: long-term reliability and effectiveness; reduction of toxicity, mobility, or volumes of waste; and cost. For the two other Decision Factors: short-term effectiveness and implementability, there were no significant advantages or disadvantages between N1 and N2. Based on the analyses of the General Standards and Decision factors in this Statement of Basis, Alternative N2 is EPA's proposed alternative for the North Area.

South Area Alternative

The four General Standards are similarly achieved with a substantially greater degree of permanence, reliability and certainty by Alternative S4 as compared with the other three South Area alternatives. Two of the five Decision Factors, long-term reliability and effectiveness, and reduction of toxicity, mobility, or volumes of waste also strongly favor S4 over the other South Areas alternatives. This advantage for S4 is greater than for N2 because South Area hazardous constituent concentrations are generally higher and occur deeper than North Area concentrations. This difference increases the relative advantages derived from their removal from the LDW. For the two other Decision Factors, short-term effectiveness and implementability, there were no significant advantages or disadvantages. The sole Decision Factor favoring S1 through S3 over S4 is cost. While the cost differential appears considerable, it is less than it would otherwise appear when the long-term costs of cap maintenance and potential cost of cap replacement are factored in. EPA has concluded the advantages of S4 (variable-depth dredge to the SQS and backfill) strongly outweigh its additional initial cost. Alternative S4 is EPA's proposed alternative for the South Area.

Other Areas

For the Southwest Bank (including Outfall 12), the 2-40's Underbuilding Area, the North Bank, and Slip 4, the proposed corrective measures are consistent with the selection of N2 and S4 for the North and South Areas and are the recommended alternatives by EPA.

Summary of Proposed Alternative

The recommended corrective action for all Plant 2 sediment areas is excavation to a target depth to remove all contaminated sediments that exceed the SQS, followed by backfilling with clean material that meets TMCLs that are protective of people who consume resident LDW seafood. EPA recognizes that sediment recontamination from upstream and/or lateral sources will be an issue in the future and projects that it will be ultimately be addressed as necessary by the CERCLA/MTCA LDW-wide process. The corrective measures selected in the Final Decision issued by EPA after public comment and EPA's Response to Comments will be performed as Final RCRA Corrective Action for Plant 2 sediments.

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FIGURES

Figure 1 – Facility Location

Figure 2 – Sediment Boundaries

Figure 3 – Area of PCB Contamination

Figure 4 – North Area Alternatives

Figure 5 – South Area Alternatives

Figure 6 – Remaining PCBs after remediation

Figure 7 – Outfall and associated 24 inch stormwater line

TABLES

Table 1 – List of Additional Sediment Studies

Table 2 – SMS/SQS/TMCL List

Table 2
CLEANUP STANDARD FOR PROPOSED REMEDY

<u>Constituent</u>	<u>SQS Value</u>	<u>TMCL</u>
Total PCBs*	12 ppm-OC	6 X 10 ⁻⁵ ppm
Cadmium	5.1 ppm	0.77 ppm
Lead	450 ppm	250 ppm
Chromium**	260 ppm	0.22 ppm
Copper	390 ppm	36 ppm
Mercury	0.41 ppm	0.07 ppm
Silver	6.1 ppm	3.7 ppm
Zinc	410 ppm	85 ppm

- * Total PCB values are values for mg/kg (Organic Carbon), whereas the remaining constituents are dry weight.
- ** the TMCL for Chromium is based on Chromium (VI)

APPENDIX